

XI.—*Alien Oligochaets in England.*

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(Read May 17, 1916)

FIGS. 16-20.

Dichogaster lageniformis sp. n.

IN a communication which I had the honour to submit to the Royal Microscopical Society in January last (6)*, some details were given of a new species of exotic Oligochaet (*Kerria rubra* Friend) which was found by me in the Botanic Garden at Oxford. The present paper deals with a second species of worm found in the same locality and at the same time. The description is based upon a series of longitudinal sections through the first 22 segments of an adult worm. Unfortunately, the specimen was found to contain a good deal of earthy matter which materially affected some of the sections, especially in the region of the gizzard. All the essential organs are, however, present in perfect condition, and it is possible to prepare such a diagnosis as will leave no important element out of calculation.

The great difficulty has been to fix the exact position which

* The figures within brackets refer to the Bibliography at the end of the paper.

EXPLANATION OF FIGURES.

The numerals refer to the number of the segment.

- Fig. 16.—Longitudinal section through segments 9-21, showing position of gizzard, intestine, œsophageal glands, prostates, and sexual organs.
 „ 17.—Seta and sac from segment 3.
 „ 18.—Spermatheca, with diverticulum and muscular layer of body-wall.
 „ 19.—Longitudinal section through anterior portion of worm (segments 1-8), showing prostomium, tongue, buccal cavity, salivary glands, pharynx, and pharyngeal gland.
 „ 20.—Diagram of segments 1-21, to illustrate the relative position of the organs.

ABBREVIATIONS.—*b.c.* buccal cavity; *br.* brain; *b.v.* blood-vessel; *c.d.* common duct; *cut.* cuticle; *d.* diverticulum; *d.v.* dorsal vessel; *gir.* girdle; *giz.* gizzard; *f.* funnel; *f.p.* female pore ♀; *int.* intestine; *int.e.* intestinal enlargement; *mus.* muscle; *m.p.* male pore ♂; *n.* nerve; *neph.* nephridium; *œs.* œsophagus; *œs.gl.* œsophageal gland; *o.f.* funnel of oviduct; *ov.* ovary; *per.* peritoneum; *ph.* pharynx; *ph.gl.* pharyngeal gland; *pr.* prostate; *pros.* prostomium; *s.sac.* sperm-sac; *s.g.* salivary gland; *sp.* spermatheca; *spz.* spermatozoa; *t.* testis; *v.v.* ventral vessel.

the species occupies. The problem is to ascertain the genus to which it belongs, and though I have placed it for the present among the *Dichogasters*, that is only because the more important characters approach those of *Dichogaster* more nearly than any genus whose diagnosis I have been able to study. By the well-known process of elimination, it was possible without difficulty to decide that the worm must belong to the extensive family of Megascolecidae. There are four pairs of simple pointed sigmoid setae in each segment. The girdle extends over segments 13 to 20, the male pore is on segment 18, and the prostates open on the two adjoining segments 17 and 19. The female pore is on segment 14, there are two pairs of spermathecae in 7/8 and 8/9, testes and funnels in 10 and 11, and ovaries in 13, while the gizzard extends from the 7th to the 10th segment. All these are characters of the Megascolecidae (10).

But this superfamily is divided into nearly half-a-score of sub-families. The œsophageal glands are too far back for the sub-family Ocerodrilinae, the spermathecae too advanced for Eudrilinae, the nephridia rule out Diplocardiinae and Acanthodrilinae, and other characters make it impossible to relate the worm to the Octochætinae and the Megascolecinae. We are thus driven to the sub-family Trigastrinae, and the genus *Dichogaster*; but even then the differences between the species now under discussion and the typical *Dichogaster* are considerable.

Following the method adopted in the paper to which I have already alluded, I propose to deal with the subject under the headings—Historical Survey, Distribution, Description, Relative Position, and Bibliography.

I.—HISTORICAL SURVEY.

The genus *Dichogaster* was created by Beddard (1) in 1888, in a very valuable paper on the "Structure of *Urochæta* and *Dichogaster*." Early investigators had depended almost entirely on dissection, and as a result the smaller forms of Annelids were far from being fully and accurately described. Beddard employed the method of sectionizing, and was able in consequence to extend and perfect the earlier descriptions. In the case of the new type, *Dichogaster damonis* Bedd., one worm was dissected, and the other studied by means of transverse sections. The main points in the original diagnosis are the following:—The setae, which are wanting ventrally in segments 17, 18, and 19, are paired and occupy the ventral side of the body; the girdle extends from the 13th to the 20th segments inclusive, and is more fully developed dorsally than ventrally. Dorsal pores present. A single pair of spermathecae in segment 8; two gizzards, separated by a very minute œso-

phageal portion, each occupy two segments, 7-8 and 9-10. Behind the gizzards, in segments 15, 16, 17, are calciferous glands, the hindmost pair smaller than the two anterior pairs, and divided into distinct lobes. Testes in 10 and 11, with vesiculæ seminalis, and funnels. Ovaries in 13 large and conspicuous with oviducts. Each spermatheca divided into two parts—a sac or ampulla, and a mulberry-like diverticulum. Length about 100 mm., from the island of Fiji.

Later, Beddard (2) defined the genus, which had in the meantime been studied and extended by Michaelsen, thus:—

“Genus *Dichogaster* Beddard. Setæ paired. Dorsal pores present. Clitellum XIII-XX (XXIII). Male pores on XVII. Two gizzards; three pairs of calciferous glands. Nephridia diffuse. Spermiducal glands tubular.”

The difficulty in defining the genus was admitted, and with Michaelsen's new species *mimus* and *hufferi* it was hard to say how it could be distinguished from the allied genus *Microdrilus*. In 1886 Benham (3) founded the genus *Trigaster* for a worm found in the West Indies (*T. lankesteri*), and later (4) in 1890 defined the genus (which had meanwhile received a new addition in Michaelsen's *T. rosca*) as follows:—

“Genus *Trigaster* Benham, 1886 (= *Benhamia* Michaelsen, 1889). Setæ in close couples, all on the ventral surface, individual setæ of each couple close together. Clitellum occupies Somites XIV to XL; complete ventrally only on the first few somites. Spermiducal pores in XVIII, and prostate pores in XVII and XIX. . . . Prostates as in *Acanthodrilus*. No penial setæ. No dorsal pores are present. Spermathecae simple pear-shaped sacs without appendices. . . . Three gizzards in Somites VII, VIII and IX. No calciferous glands. Anterior masses of nephridial tubules in Somites IV, V, VI grouped to form peptonephridia.”

In his Monograph of the Order Oligochaeta (2) Beddard separates the two genera *Dichogaster* and *Trigaster* by a great distance, but places *Trigaster* in close proximity to *Benhamia*. Indeed, the two genera show many points of divergence. Yet Michaelsen (10) in his volume on “The Oligochaeta” makes the two genera into a sub-family which he names *Trigastrinae*. One might question the propriety of this, but that is a matter of opinion. The sub-family is distinguished by the following marks:—Setæ 8 per segment, girdle extending over 4 to 27 segments, and beginning on or near segment 14. Male pores on 18, 17 or 19, prostate pores on 17-19. One or two pairs of spermathecae opening in 7/8, 8/9. Two or three muscular gizzards in advance of the male organs, and three pairs of calciferous glands usually present at the posterior end of the oesophagus.

The main distinction between *Trigaster* and *Dichogaster* is said to lie in the latter relation. *Trigaster* has no calciferous glands

behind the ovary, while in *Dichogaster* there are usually three pairs of these organs present.

Since Beddard founded the genus *Dichogaster* it has been greatly extended, Michaelsen, so long ago as 1900, enumerating no fewer than 67 species. His definition of the genus so extended is as follows:—

“Setæ in pairs on the ventral side. Prostate pores 1–3 pairs on 17–19 segments. Spermathecae 1 or 2 pairs opening in 7/8, 8/9. Two gizzards anterior to the male organs; sometimes only 2 pairs, but usually 3 pairs of calciferous glands behind the segment which carries the ovary, usually in segments 15–17, in rare cases beginning one segment earlier. So far as known two pairs of testes and funnels.” A good deal is to be desired in this definition, and doubtless as our knowledge of this large and complex group of worms increases things will assume a more satisfactory form.

II.—DISTRIBUTION.

The first species of *Dichogaster* to be described was received by Beddard from Fiji (*D. damonis*). In 1891 Michaelsen described a second species (*D. mimus*) from Accra, West Africa (9); and a third species the same year (8) from the same country. In 1900 (10) he summarized the known distribution in the following words:—“Tropical Africa (from Abyssinia to Mozambique on the one side, and from Portuguese West Africa to the Congo on the other), Antilles, America (from California to Guatemala and Dutch Guayana), Polynesia, Hawaii, Isle of Sunda, South Asia. Certainly endemic in Tropical Africa, and probably so for the Antilles and Central America. Some species have been introduced into various lands, including Upper Guinea, Madagascar, the Antilles, California, Mexico, Venezuela, Paraguay, Argentina, Germany and the East Indies.” We have no means of knowing the original home of the species now under review.

III.—DESCRIPTION OF *Dichogaster lageniformis* sp. n.

As stated in my former paper, two years ago, while on a visit to Oxford I found in the Lily House at the Botanical Garden a species of worm which I had not previously seen. It was very tender, and perished before I could reach home. In June, 1915, I was able to pay another visit to the Garden, when I found *Kerria rubra*, *Dichogaster lageniformis*, and another worm which still awaits description. It is upon longitudinal sections of these worms that our present study is based.

External Characters.—*Dichogaster lageniformis* is a small slender and delicate worm, extending when in motion to about

1½ inches (35–40 mm.), but contracting to about half that length and to a breadth of 1 mm. in the widest part when preserved in alcohol. It is similar in appearance to *Kerria rubra* when living, but shorter and smaller. The head is “zygobisch,” and forms a strong upper lip. There is no head-pore, nor could I find any trace of other pores in the dorsal region of the body. The girdle

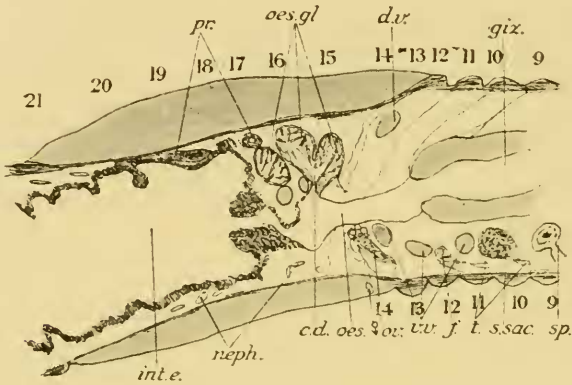


FIG. 16.

extends from the 13th to the 20th or 21st segment inclusive, and is very much developed dorsally (fig. 16). In front of the girdle there could be seen in the living worm a greenish stripe or longitudinal band internally. This is the gizzard. In the preserved

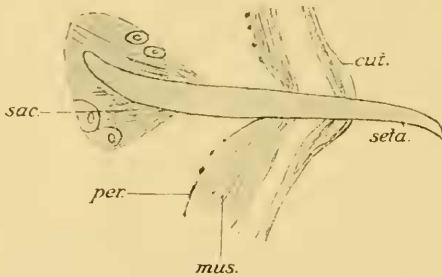


FIG. 17.

worm the intersegmental grooves are very deep, except in the case of the first three or four. The worm emits a good deal of turbid white matter when placed in alcohol. In this respect it reminds one of our British mucous worm (*Eisenia rosea* Sav.). The setæ are eight per segment, sigmoid (fig. 17) in four pairs on the ventral surface. I can find no evidence of ornamented or

penial setæ, neither do the setæ near the male or female apertures seem to be lacking as in *D. damonis*.

Negative Characters.—In my former paper it was observed that a fuller account of the negative peculiarities of new worms would often be of great service in diagnosis. The following points have been observed in the present species. There is an absence of pores on the dorsal region so far as the longitudinal sections extend, i.e. from the head to the posterior girdle-segment. Nephridia seem to be lacking until segment 12/13. There are no thickened septa, no penial setæ, no celomic corpuscles, and there seems to be an entire absence of penial bulbs and prostate papillæ. The only swollen portion which I have been able to detect is related to the female pore on the ventral surface of segment 14.

Internal Characters.—The internal structure has been most carefully studied by means of a complete series of longitudinal sections extending from the prostomium to the girdle inclusive. As already intimated, some of the sections are torn, owing to the presence of grit in the intestine. In many sections also the septa are either wanting or so congested that it takes a considerable time before one can be quite positive in certain cases to which segment a given organ is to be referred. By dint of frequent drawing and repeated revision, however, all difficulties have been overcome or reduced to unimportance.

The sexual organs, because of their importance, demand our first attention. The most advanced of these organs are the spermathecæ. Of these there are two pairs (as in *Kerria rubra*) opening in the inter-segments 7/8 and 8/9. They may be best described perhaps as hour-glass or bottle-gourd shaped, and this peculiarity has suggested the trivial name.* They are not attached to the œsophagus, but lie free in the cœlom; the foremost pair being smaller than the posterior. What may be regarded as a degenerate diverticulum is found on the anterior face of each spermathecæ. The spermatozoa, which I found here very sparsely, were in the early stage of development, while those present in the duct and ampulla were flagellate (fig. 18). In the duct there seemed to be distinct evidence that the spermatozoa were held together by a gelatinous cement. Although aliens in England, these worms were evidently quite at home. They cannot, I am told, have been imported in very recent years, but must have bred in the house for a long time, and the duct and ampulla were crowded with spermatozoa, showing that there had been intercourse between the individuals.

The testes are as usual situated in segments 10 and 11, where also may be seen the funnels, staining deeply on account of the

* *Lageniformis*, or having the shape of a flagon, hour-glass, or bottle-gourd. From the word *lagena*, λάγηνος, a flagon, the term *Lagenaria* has been derived. This is the generic name of the plants bearing bottle-gourds.

masses of spermatozoa. The ovary is in the normal position on the posterior side of the septum 12/13, while the funnel is on the anterior of 13/14, the duct opening anteriorly in segment 14. There is only one pore in this case. There are two prostates in 17 and 19, the opening of the male duct lying in the intermediate section. Only in the case of the oviduct do I find any distinct papilla, and there are no penial bulbs or protuberances in the specimen under review. The prostates are of uniform size throughout, and do not end in a muscular portion, as is sometimes the case.

The glandular system is rich and extensive. It includes salivary, pharyngeal and cesophageal or calciferous glands, each of

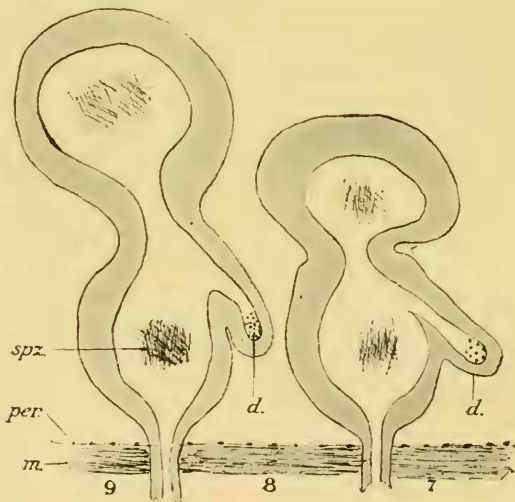


FIG. 18.

which merits attention. Beginning at the head we first discover a pair of glands, one dorsal and the other ventral, extending through segments 3 to 6 or thereabouts. They are not attached to the cesophagus, but to the peritoneum, and constitute the glands *à mucosité*, peptonephridia, or salivary glands of different authors. Benham (4) figures them as occurring in segments 1-3 only in typical *Dichogaster*. They possess no funnels, and are somewhat more dense or compact than is the case with similar organs in the Enchytræids, as shown, for example, in *Henlea fragilis* Friend (5). They coil round the posterior region of the pharyngeal gland, but are in no way attached thereto. The pharyngeal gland is seen to be closely associated with the pharynx, from which it is distin-

guished by the free manner in which it stains. There are no ducts from the gland to the pharynx, nor is the gland divided up, as is the case with the septal glands found in many other worms in this region of the body. In *Kerria rubra* Friend (6) the septa in this region are thickened to carry the glands, but in *Dichogaster lageniformis* there is no such thickening, and the septa give no indication of any close relationship with the glandular mass. At the same time one naturally assumes that the pharyngeal gland of *Dichogaster* is homologous with the septal glands of *Kerria* and other worms belonging to this family.

The cesophageal or calciferous glands are found in segments 15-17, which is the normal position for this genus, and constitutes perhaps the chief argument for regarding the new worm as a true *Dichogaster*. I use the alternative terms, because, while the glands are in part of the true cesophageal type, composed of alternate rods and open spaces, in part they are also solid and

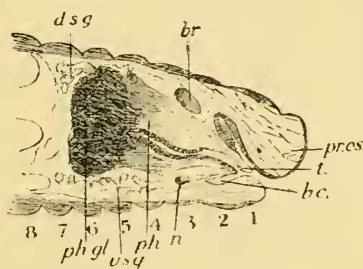


FIG. 19.

have all the appearance of calciferous glands. A reference to Benham's diagrams (4) shows that *Dichogaster* was the only genus then known which had three pairs of glands in this position. The hindmost gland is the largest, while the two anterior glands open by a common duct (fig. 16) into the cesophagus. I give a drawing of a section showing this interesting peculiarity. The structure of the main portion of the gland exactly corresponds with that of *Henlea fragilis* (5).

If, now, we turn to the digestive and alimentary region, we find some further features of interest. The tongue or taste-organ (fig. 19) is well developed. The pharynx is very simple in structure, and together with the pharyngeal gland extends back to the end of segment 6. In the 7th segment the gizzard commences. This organ has a constriction about midway, but owing to its torn condition, through being filled with grit when sectionized, its exact shape cannot be determined. It extends to the septum 10/11, but this is pushed back to the beginning of the girdle in

section 13, so that the gizzard appears to extend through six segments (7-12), as shown in the illustration (fig. 20). On the posterior portion of the oesophagus the calciferous glands occur, and immediately behind these, in segment 18, or possibly 19, the wide intestine opens out, lined with a very moderate typhlosole. The segments behind the girdle have not been studied.

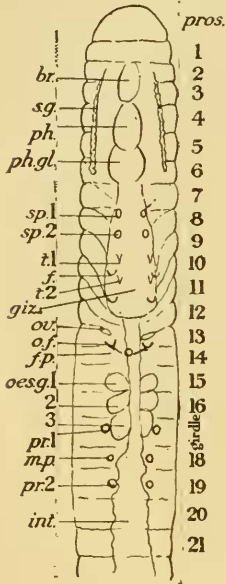


FIG. 20.

The nervous system is normal. One observes that the nerve-cord narrows at each intersegment, and this fact is often of great assistance in determining the number of a given segment when the septum is wanting, or is pushed out of position by the crowding of the organs.

The nephridia are of the microscopic type, and seem to commence in segment 12/13. I have been unable to discover their pores or funnels, and they are in every way different from the corresponding organs in the Enchytraeids, which I have studied most fully.

The vascular system seems to differ from the type. I find the blood-vessels very large in segments 12, 13, 14, but there are lesser "hearts" in 15 and 16. The system was not studied in the living worm, and

reference must be made to the drawings for such details as it is possible to portray. Longitudinal sections show capillaries in the epidermis. In some of my sections they appear to be specially large and numerous in the 6th segment.

IV.—RELATIVE POSITION OF *Dichogaster lageniformis*.

I confess to having considerable difficulty in finding the exact place which the new worm fits. It may be asked in the first instance—Is it a *Dichogaster* at all? So far as the setæ, extent and position of the clitellum, gizzard and oesophageal glands are concerned it agrees with the original type. The testes and ovaries are also in the normal position, but this would apply to all the genera of the family. *D. damonis*, the type, has only one pair of spermathecae, but the more recent diagnosis allows of either one or two pairs. In the type one finds the setæ of certain segments missing, there are vesiculæ seminalis of a special kind, each oviduct opens separately instead of being fused, and the salivary glands in the anterior segments seem to be confined to the first three segments.

On the other hand, the recent additions to the list of species include many forms which differ widely from the type. As understood to-day, the genus *Dichogaster* may include worms which have either one or two pairs of spermathecae, one, two or three pairs of prostates, penial setae present or absent, spermathecae with or without diverticula, girdle saddle-shaped or ring-formed, either two or three pairs of oesophageal glands, and a number of other variations. I do not know of any character in the worm under consideration which makes it impossible for it to fit into this genus, or which would ally it more closely to any other. Our information about the presence or absence of a tongue or taste organ, and the existence of one or more peptonephridia in other species is not very complete, but these are not generic differences.*

If we sum up the most important points we shall be able to discover what species come nearest to *D. lageniformis*. There are two pairs of spermathecae and two pairs of prostates. There are no penial setae, and the diverticula of the spermathecae are only imperfectly developed. There are three pairs of oesophageal glands, the girdle covers segments 13-20, and the oviducts have but one pore. In some of these particulars *D. caecifera*, in others *D. inermis* and *D. heteronephra* are related thereto. But these are all very large worms, while our present species is a pigmy, and they vary in many other ways as well.

D. lageniformis must therefore, for the present, be regarded as occupying a position somewhat apart, the difficulty of placing it being enhanced by the fact that we have no clue to its original home.

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* See Benham, Quart. Journ. Micr. Sci., xxxi. (1890) pp. 288-89.